Results of Preliminary Mark-Recapture Experiments with Juvenile Salmonids on Sturgeon and Roberts Bank, Fraser River Estuary

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RESULTS OF PRELIMINARY MARK-RECAPTURE EXPERIMENTS WITH JUVENILE SALMONIDS ON STURGEON AND ROBERTS BANK, FRASER RIVER ESTUARY

by

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ABSTRACT

Levings, C. D., G. L. Greer and P. Miller. 1983. Results of preliminary mark-recapture experiments with juvenile salmonids on Sturgeon and Roberts Bank, Fraser River estuary. Can. MS Rep. Fish. Aquat. Sci. 1684: iii + 27 p.

Results of preliminary marking experiments with juvenile chum and chinook salmon are given for release and recapture studies in May and June 1981 at three low tide refuges on Roberts and Sturgeon Banks at the Fraser River estuary. Spray marking with fluorescent grit was the technique used. Residency periods of up to two days were documented. The recapture of marked fish over this length of time was unexpected considering the relatively few marked fish (2500) that were released at each site and potential dilution by recruits from the immediately adjacent Strait of Georgia.

RÉSUMÉ

Levings, C. D., G. L. Greer and P. Miller. 1983. Results of preliminary mark-recapture experiments with juvenile salmonids on Sturgeon and Roberts Bank, Fraser River estuary. Can. MS Rep. Fish. Aquat. Sci. 1684: iii + 27 p.

Le présent rapport porte sur les résultats d'expériences préliminaires de marquage de saumons quinnats et cohos juvéniles. Ces études de mise en liberté et de capture ont été réalisées en mai et juin 1981 dans trois refuges à marée basse des bancs Roberts et Sturgeon, dans l'estuaire du fleuve Fraser. Les saumons ont été marqués à l'aide de poussière fluorescente en aérosol. On a observé des périodes de séjour allant jusqu'à deux jours. La capture de poissons marqués pendant ce temps a été inattendue étant donné le nombre peu élevé de poissons marqués (2500) mis en liberté à chaque emplacement et l'adjonction potentielle des recrues du détroit de Géorgie adjacent.

INTRODUCTION

The experiments described below were part of a larger study investigating the juvenile salmonid use of foreshore habitats on Sturgeon and Roberts Bank in the Fraser River estuary. In that study, beach seine catches at sites characterized by eel grass on Roberts Bank were compared with two locations in sandflat habitat on Sturgeon Bank. Data from those surveys are presented elsewhere (Conlin et al. 1982). In the present study, preliminary mark and recapture experiments with juvenile chum (Oncorhynchus keta) and chinook (O. tshawytscha) were conducted in May and June 1981 to provide information on residency and short-term migrations within the estuary.

To our knowledge, only one other attempt at estuarine marking and recapture of juvenile chinooks has been made in B.C. waters. Those studies were carried out by Armstrong and Argue (1977) and Argue et al. (1979) using nose tagged (coded wire tag) juvenile chinook in the Cowichan estuary. Levy et al. (1979) spray marked chinook fry in the Duck-Barber-Woodward Island area of the lower Fraser River, but their study location was actually in riverine habitat where freshwater was the dominating influence. Healey et al. (1979) spray marked juvenile chum in the lower Nanaimo River but then determined their residency in the estuary. Mason (1974) fin clipped chum fry at the Lynn Creek estuary on the east coast of Vancouver Island, and most of the stations this author used were within the influence of river water also.

Procedures used and problems arising in carrying out the present study are explained in some detail for the benefit of those planning similar experiments.

METHODS

SPRAY MARKING AND EXAMINING FOR MARKS

Twenty to fifty fish were removed at a time from holding tanks (300-450 L) using a dip net and then submerged while contained in the net in an 18-L bucket of water obtained at the holding site and containing 75 mg of MS-222 anesthetic. The fish were held in the anesthetizing solution for 15-20 seconds until they began to lose equilibrium. Once the fish became lightly anesthesized they were transferred from the dip net to a square, clamp-like apparatus made of 0.5-cm plastic mesh attached to two wooden frames hinged together. This device held the fish immobile and permitted both sides of the fish to be coated quickly and evenly with the fluorescent grit, which was applied using compressed air at 550 kPa (80 psi) and a spray gun held about 30 cm from the holding frame. Generally the techniques used by Healey et al. (1979) were followed.

The fish were counted after application of the fluorescent grit and returned immediately to recovery tanks (300-450 L) aerated either with oxygen from portable cylinders or from a shipboard compressed air supply. The entire spraying procedure lasted between 1.5-2 minutes from removal of fish from the holding tanks to placement in recovery tanks. Fish usually began to recover within 2-3 minutes. They were held in recovery tanks until release at the appropriate site.

A darkened laboratory on board the research barge L. PACIFICA or a portable dark viewing box was used with an ultra-violet light to check recaptured salmon for presence of the fluorescent grit. All salmonids captured during subsequent seining were placed in dip nets in lots of 10-25 fish and then submerged, as above, in anesthetic solution but until they were immobile. The fish were then transferred onto a tray consisting of a cloth mesh attached to a wooden frame, placed inside the dark box and examined for marks. The tray was then removed from the box and a second identical mesh tray placed over the first. The trays were gently flipped over and the fish re-examined. In this way both sides of all fish were checked for the presence of marks. Usually examination of a batch of fish took about 30 seconds and all marked fish detected were retained. The examined fish were returned to containers of water to recover from the anesthetic but not released until seining at each recapture site was completed. Mortalities during the viewing procedure averaged about 16%.

Subsamples of fish that died during collecting, spray marking and viewing were preserved in 10% formalin. These specimens were used to verify species identifications and for length measurements.

FISH CAPTURE AND RELEASE

Sturgeon Bank

Juvenile chinook were taken by beach seine at two sites for the marking experiments on Sturgeon Bank, namely, Garry Point slough and Steveston pit. Very few juvenile salmonids of other species were obtained, and so sorting by species before marking was unnecessary. The latter location is a relict river channel on the southwest portion of Sturgeon Bank (Fig. 1a) and also one of the study areas examined in the comparative habitat study referred to in the Introduction (Conlin et al. 1982).

Captured fish were placed in plastic holding tanks (450 L) and transported in a 7-m herring skiff or in one of two inflatable boats (3 m and 4 m in length) used in the work. The water in the holding tanks was obtained from sites where beach seines were made. The holding tanks were fitted with battery-powered aerators.

Fish caught at Garry Point slough on May 4 (10 sets; 991 fish) were marked soon after capture and the marked fish transported (ca. 30 min) to Steveston Harbor where a shipboard (DFO research barge, L.

PACIFICA) air supply provided aeration for the holding tanks. On the following day (May 5) 880 marked chinook were transported within one hour to Steveston pit and released at Station 6 (Fig 1b) at approximately 1245 h (ca. 1 h after low slack tide). Battery operated aerators were placed in the holding tanks while in transit.

On the first day following release (May 6) 1935 chinook fry caught at Steveston Pit (8 sets), primarily at Stations 1 and 2 (Figure 1b), were brought back to Steveston and held at the barge with aeration. On May 7 these fish were anesthetized and checked for marks using an ultraviolet lamp in a darkened laboratory on L. PACIFICA. After revival, they were marked and then transported back to Steveston Pit where 1215 chinook were released at 1745 h on a flood tide.

On May 19, beach seining again was conducted at Steveston Pit resulting in the capture of 387 chinook in 10 seines. All fish were examined for marks aboard L. PACIFICA and spray marked on the same day. On May 20, 366 chinook were transported to the Iona sewage channel study site (Fig. 1b) and released about 800 m seaward of the end of the jetty at 1330 h on a flood tide.

Roberts Bank

Beach seining for fish marking experiments on Roberts Bank was conducted along the east shore of the Westshore Terminals dock (Fig. 1c). A number of sites were found to be most productive, particularly one near the launch ramp (Stn. D; Fig. 1c) and another at the south end of the cobble beach (Stn. H; Fig. 1c).

On May 21, 681 fish were taken in 10 seines along the cobble beach between 1050 and 1415 h. These fish were placed in aerated holding tanks on a herring skiff. Both chinook and chum were present in the catches but because of the additional mortality that could be induced by further handling the two species were not separated for marking. Over 70% of the fish caught were juvenile chum, as determined by direct observation of the beach seine catches. Judging from the species composition of fish mortalities that did occur at this study location (223 fish), 17.9% of the catch were chinook and 82.6% chum, using the same proportions determined by observations of catch composition. Using these data for percent composition, approximately 82 chinook and 375 chum were spray marked and released at 1530 h on a flooding tide, at the launch ramp site (Stn. E).

On June 1-3, 73 beach seines were completed at 11 sites in the inter causeway area (Fig. 1c) to take fish for a more intensive marking experiment. On June 1 approximately 1200 fish were taken in 21 hauls, on June 2 about 2000 were taken in 44 hauls, and on June 3 475 fish were taken in 8 hauls.

The fish that were caught during June 1-3 were counted and placed in 18-L buckets of water containing battery-operated aerators before being transported to a 1-m^3 live cage. On June 1 this cage was suspended from R/V ACTIVE LASS which was used as a support vessel for

this work and kept anchored off the coal port (Fig. 1c). Because of strong tidal currents the mesh net began to part from the live cage so these fish were temporarily moved to three 450-L plastic holding tanks in the herring skiff and held overnight with aeration. On June 2 the live cage and fish were relocated to an anchored float off Station A (Fig. 1c) where tidal currents were weaker; all fish subsequently caught on Roberts Bank for marking were held at this location.

It was possible to effect a decrease in the high mortality (approx. 30%) occurring on June 1 within the live cage by increasing the frequency of trips made from the seining site to the cage with the freshly caught fish. The decrease in mortality may be attributed to the reduction in the length of time the fish spent in the small 18-L collection buckets.

Subsamples of the mortalities occurring in the live cage during June 1-3 were collected and preserved. These fish were later identified, counted, weighed, and measured for fork length.

On the afternoon of June 3, and on a rising tide (1400-1530 h), 2248 marked fish were released over the eel grass beds at the landward end of the borrow pit (Fig. 1c). A small subsample of 35 marked fish was retained and preserved. To determine post-spraying mortality, 102 marked salmon were retained in the live cage. Unfortunately, this pen was lost from its mooring the following night.

The species composition of the marked fish liberated on June 3 in the Roberts Bank study area, as judged from estimates at the time of release, was 77.1% chinook and 22.9% chum. Therefore we estimate 1733 marked chinook and 515 marked chum were released (Table 1).

OCEANOGRAPHIC CONDITIONS

Observations of temperature and salinity were not made concurrently with the mark-recapture work, but data from the more extensive study (Conlin et al. 1982) are complementary. This information was used to characterize the environment where the fish were caught and released.

Because of the pervading influence of the Fraser River on Sturgeon Bank, surface water at Steveston Pit and Garry Point is usually brackish. Surface temperature at Steveston Pit on May 5 and 21 ranged from 14-17°C and surface salinity from 7-11°/... At Iona, on May 19, surface temperature was 16°C and salinity ranged from 5-8°/.. at the five stations sampled.

Between the two causeways on Roberts Bank, fresh water effects of the Fraser River are reduced and salinities are generally higher than on Sturgeon Bank or northern Roberts Bank. At seven stations around the borrow pit and on the cobble beach, surface salinities ranged from 14-20°/.. on June 1, 1981. Temperatures were also higher and ranged from 17-18°C.

RESULTS

RECOVERY OF MARKED FISH

Iona

On May 21, 850 chinook were taken in 10 beach seines (1230-1600 h) at stations 4, 5 and 6 at the seaward end of the Iona sewage channel (Fig. 1a). Fish were checked for marks on-site using a portable dark box. No marked fish were located (Table 2).

Steveston pit

On May 6, four replicate beach seines (1215-1315 h) were made at Station 6 (Fig. 1b) on the southwest sandbar to recapture marked fish. Only 17 fish were obtained. About 1 h later the beach on thenortheast side of the pit began to be exposed and seining shifted to that location. Fish were more abundant here and about 1200 chinook were taken in 4 sets in the area of Stns. 1 and 2 (Fig. 1b) during the period 1400-1445 h. These fish were placed in buckets and returned to Steveston to be counted and examined for marks. Three marks were found among the 1215 chinook examined. The unmarked fish were marked and released the next day (Table 2).

On May 19, 387 chinook were caught in Steveston pit; 134 in 6 seines on the southwest sand bar and 253 in 4 seines on the north beach. These fish were checked for marks on site using a portable dark box. None were found (Table 2).

Roberts Bank

On May 22, 594 fish (10 seines) were caught on the cobble beach between 1130 h and 1530 h, anaesthetized, and inspected for marks. No marked fish were found. The species composition of the mortalities from this exercise (n=161) was 2% chinook and 98% chum (Table 1).

On June 4 (1300-2040 h), beach seining was conducted at four sites around the rim of the borrow pit (10 sets) and at five sites (10 sets) on the cobble beach at the coal port (Fig. 1c, Table 1). A total of 878 salmonids was caught at the borrow pit between 1325 h and 1500 h. Two marked chinook were recaptured at Stn. B at 1445 h. As estimated from the species composition of 79 fish that died during the mark inspection procedures, 78.5% were chinook and the remainder were chum (18.9%) and coho (2.5%). A total of 10 marked chum were obtained from 950 salmonids taken along the cobble beach between 1800 h and 2030 h. The distribution of marks at these seining sites were: 2-Stn. D, 2-Stn. H, 5-Stn. A, 1-Stn. E. During the mark examination procedure, 218 fish died of which 69.7% were chum, 29.4% chinook, and 1.2% coho.

On June 5, 404 salmonids were recovered from 9 sets made in the borrow pit at Stns. B and C. Two marked chinook were taken at Stn. C between 1430 h and 1500 h. Of the 56 fish that died during inspection for marks, 69.6% were chinook, 16.1% were chum, and 14.3% were coho.

LENGTH DISTRIBUTION OF FISH

Sturgeon Bank

Fish captured for marking from Garry Point Slough, May 4 and 19

On May 4, chinook were the only species caught at this location and showed a very distinct mode in the 40-50 mm length range (Fig. 2a). Chinook obtained about two weeks later (May 19) at Garry Point had the same modal length but showed a slightly different length frequency distribution, with a few more larger fish in the 50-60 mm class (Fig. 2b). Chinook taken on May 6 in beach seines on the north shore of Steveston pit were larger than those from Garry Point on the same date, with a distinct modal peak in length frequency ranging between 50 and 60 mm (Fig. 2c). In addition, about half of these fish had lengths ranging up to the 90 mm class.

Roberts Bank

Fish captured for marking on coal port shoreline, June 1-3

Length-frequency histograms of fish taken during June 1-3 by beach seine along the northeast shore of the coal port are shown in Fig. 3. Most chinook were in the 60-70 mm range but chum showed a distinct mode at 60 mm length. Fish which died in live cages while being held for marking showed similar size distributions (Fig. 3). The chinook and chum released after marking also showed length distributions very similar to those described above, as judged by measurements from fish that died during the marking procedure (Fig. 3).

Sampling for marked fish in the borrow pit, June 4-5

Chinook from the borrow pit showed peaks in length frequency at 80-100 mm (Fig. 4). However, three of the four marked chinook recovered were slightly smaller than the modal sizes shown in Figure 4. Lengths of these four chinook were as follows: 94 mm, 74 mm, 68 mm, and 67 mm. Chum showed a modest peak in length frequency at 70 mm (Fig. 4).

Sampling for marked fish on coal port shoreline, June 4

Chum and chinook caught by beach seine along the cobble beach of the coal port shoreline were smaller than those taken on the same day at the borrow pit. Both species showed distinct modes at 60 mm and 70 mm (Fig. 5). The length frequency of the 10 marked chum recaptured at this location were within the following ranges: 40-49 mm (1); 50-59 mm (0); 60-69 mm (2); 70-79 mm (4); 80-89 mm (3).

Coho

A few coho were obtained on Roberts Bank and their length data are presented even though this species was not a focus of the study. During June 1-3, when fish were obtained for marking, 4 coho were present in the total sample of 1187 salmonids. During sampling to recover marked fish more coho were obtained, especially at the borrow pit stations. Fifteen coho taken in the beach seining around the pit on June 4 ranged from 80-125 mm in length (Fig. 6). On the same day only 2 coho (60-70 mm) were obtained on the coal port beach. On June 5, 8 coho taken at the borrow pit ranged from 80-120 mm in length (Fig. 6).

DISCUSSION

MORTALITIES

Mortality rates during catching and holding the fish were highest (17-32%) on Roberts Bank, especially when chum were abundant in samples. On Roberts Bank many beach seine hauls were made on a cobble beach where eel grass in the lower intertidal zone had heavy growths of filamentous diatoms. Through the dragging action of the advancing seine lead-line these siliceous algae may have become dislodged and caused damage or clogging of the gills of the fish as they were hauled to the beach. In addition, the fish may have experienced some body abrasions when seined onto the rocky shore. On June 4 and 5, while seining for marks around the borrow pit, fish were seined onto an algae-free sandy shore and mortality was lower (7%-14%). However, most of the fish captured in this location were chinook which, in general, appeared to better withstand the handling procedures for the marking experiments.

Mortalities from experiments on Sturgeon Bank, where small chinook dominated the catches, were much lower ranging from 7-13%. Beaches in this area were all sand or mud. An exception to this relatively low handling mortality was the sampling on May 6 when chinook were brought from Steveston Pit to Steveston Harbor. This trip had to be made around Sandheads and because of motor problems travel time was almost 2 h. Mortality in these fish was about 37%.

As pointed out by Strange and Kennedy (1982) juvenile salmonids debilitated due to handling and naturally stressed during smoltification are more susceptible to mortality during spray marking. Both factors were probably involved in our work, especially at Roberts Bank. Both chum and chinook caught at Roberts Bank were larger than fry and were exposed to relatively high salinities. These fish might therefore be expected to be smoltifying.

RECOVERY OF MARKS AND FISH DISTRIBUTIONS

Although the recovery of marked fish from the experiments was extremely low, the fact that any marked fish at all were recovered indicates that the short-term dilution rate of the local population from new "recruits" must be minimal. This was particularly surprising at Roberts Bank where the eel grass habitats close to Westshore Terminals are in effect part of an island in the Strait of Georgia where millions of juvenile salmon migrate and rear.

These preliminary results indicate that juvenile chum and chinook may have different habitat preferences. On Roberts Bank where two distinctly different habitats occurred within the same temperature and salinity regimes, marked chum released at the borrow pit were recovered at the cobble beach whereas chinook released at the borrow pit were recovered there. Further interpretation of the distributional data available (e.g. Greer et al. 1980; Conlin et al. 1982) is required to confirm these habitat preferences.

There was also evidence of size differences of fish using the various habitats. On Sturgeon Bank chinook caught in the area of Stns. 1-3 on the north shore of the Steveston Pit (Fig. 1b) on May 6 showed a wider size range (50-90 mm; Fig. 2) compared to those taken on May 14 at the southwest sandbar (Stn. 6) in the complementary study of Conlin et al. (1982). The fish in that study showed a well defined peak at 40-50 mm length, similar to those obtained at Garry Point on May 4 (Fig. 2). On Roberts Bank both chum and chinook were larger at the borrow pit (Fig. 4) compared to those caught at the cobble beach along the coal port (Fig. 5). In addition, the marked chum caught at the latter location after release at the borrow pit were smaller than those naturally occurring at the borrow pit. Therefore, the dispersal of this species to the cobble beach from the borrow pit may have been related to size as well as to habitat preference.

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This work, conducted in a difficult and expansive study area, would not have been possible without the help of the following personnel: D. K. Gordon, M. Kotyk, B. Piercey, K. Feng, and S. Matheson.

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Table 1. Data on marked chum and chinook releases and recaptures on Roberts Bank, May 21 to June 5, 1981.

ROBERTS BANK RELEASES				ROBERTS BANK RECAPTURES			
Capture site, Date (1981)	Release site, Date (1981)	Number of marked chum released (estimate)	Number of marked chinook released (estimate)	Recovery site, Date (1981)	Number of fish examined for marks	Number of marked chum recovered	Number of marked chinook recovered
Stn. E; May 21	Stn. E; May 21	375	82	Stn. E, May 22	594	0	0
Stns. A,B,C,D, E,F,G,H,I,J,T; June 1-3	Stn. B; June 3	515	1733	Stns. B,C,G, J; June 4	878	0	2
				Stns. A,D,E, H; June 4	950	10	0
				Stns. B,C; June 5	404	0	2

Table 2. Data on marked chinook releases and recapture on Sturgeon Bank, May 4-21, 1981.

STURGEON BANK RELEASES			STURGEON BANK RECAPTURES		
Capture Site, Date (1981)	Release Site, Date (1981)	Number of marked chinook released	Recovery site, Date (1981)	Number of chinook examined for marks	Number of marked chinook observed
Garry Point slough; May 4	Steveston pit Stn. 6; May 5	880	Steveston pit Stns. 1,2; May 6	1935	3
Steveston pit Stns. 1,2; May 6	Steveston pit Stns. 6; May 7	1215	Steveston pit Stns. 1,2,6; May 19	387	0
Steveston pit Stns. 1,2,6; May 19	Iona pit est. 800 m seaward of end of the jetty	366	Iona pit, Stns. 4,5,6; May 21	850	0

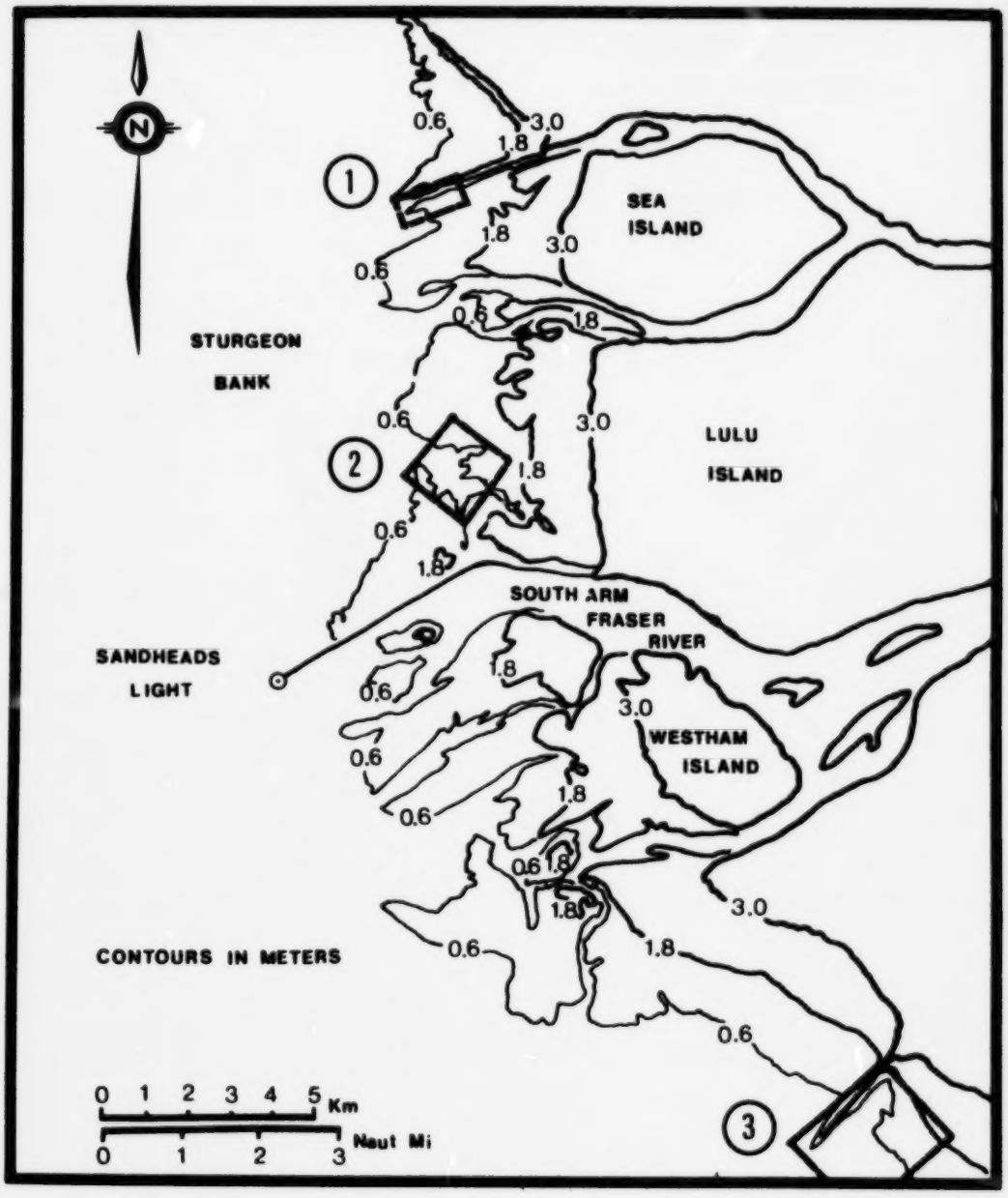


Fig. 1a. Chart showing general location of the study areas on Sturgeon and Roberts Banks, Fraser River estuary .

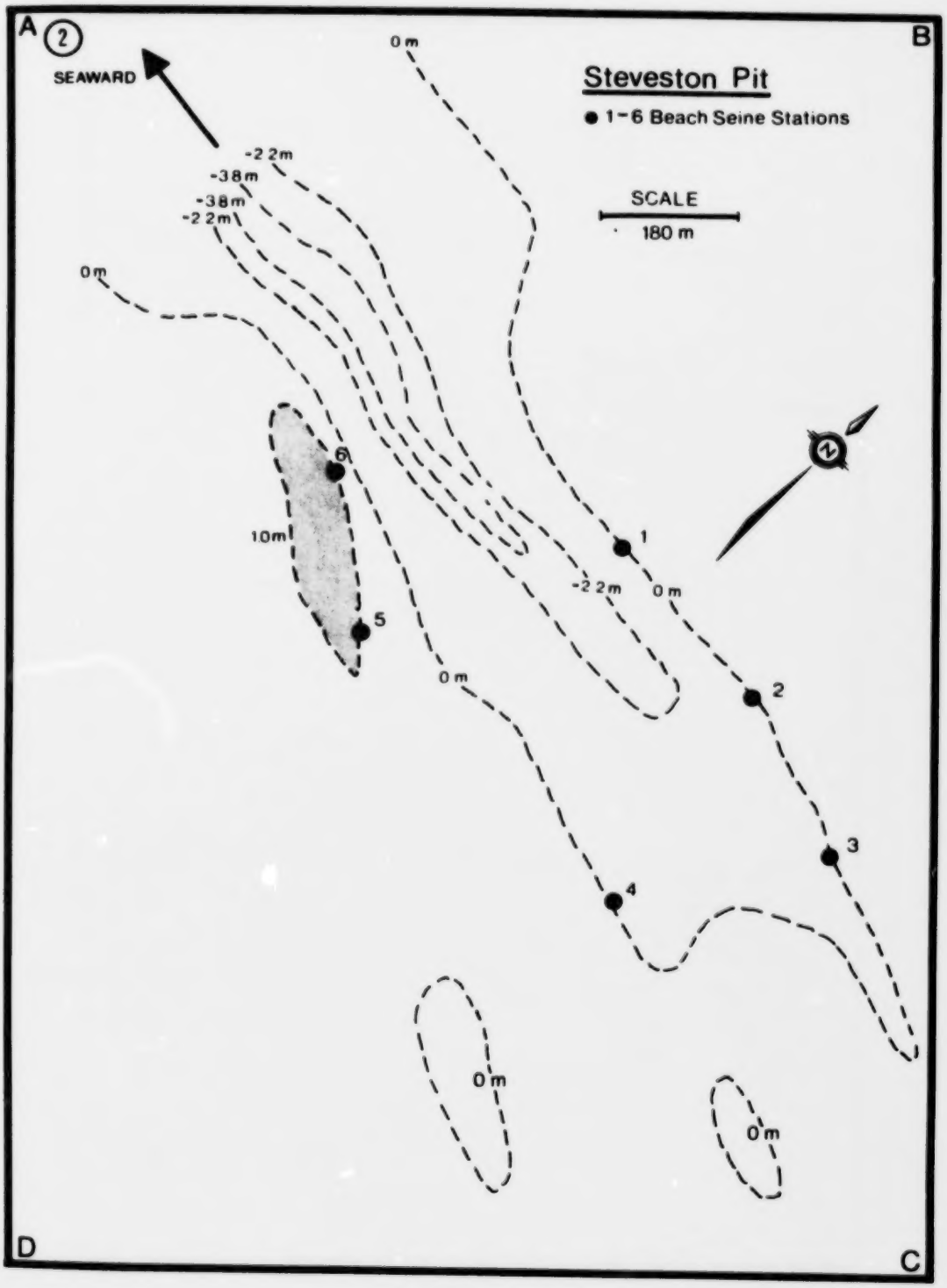


Fig. 1b. Detailed bathymetery and station locations at Steveston Pit on Sturgeon Bank.

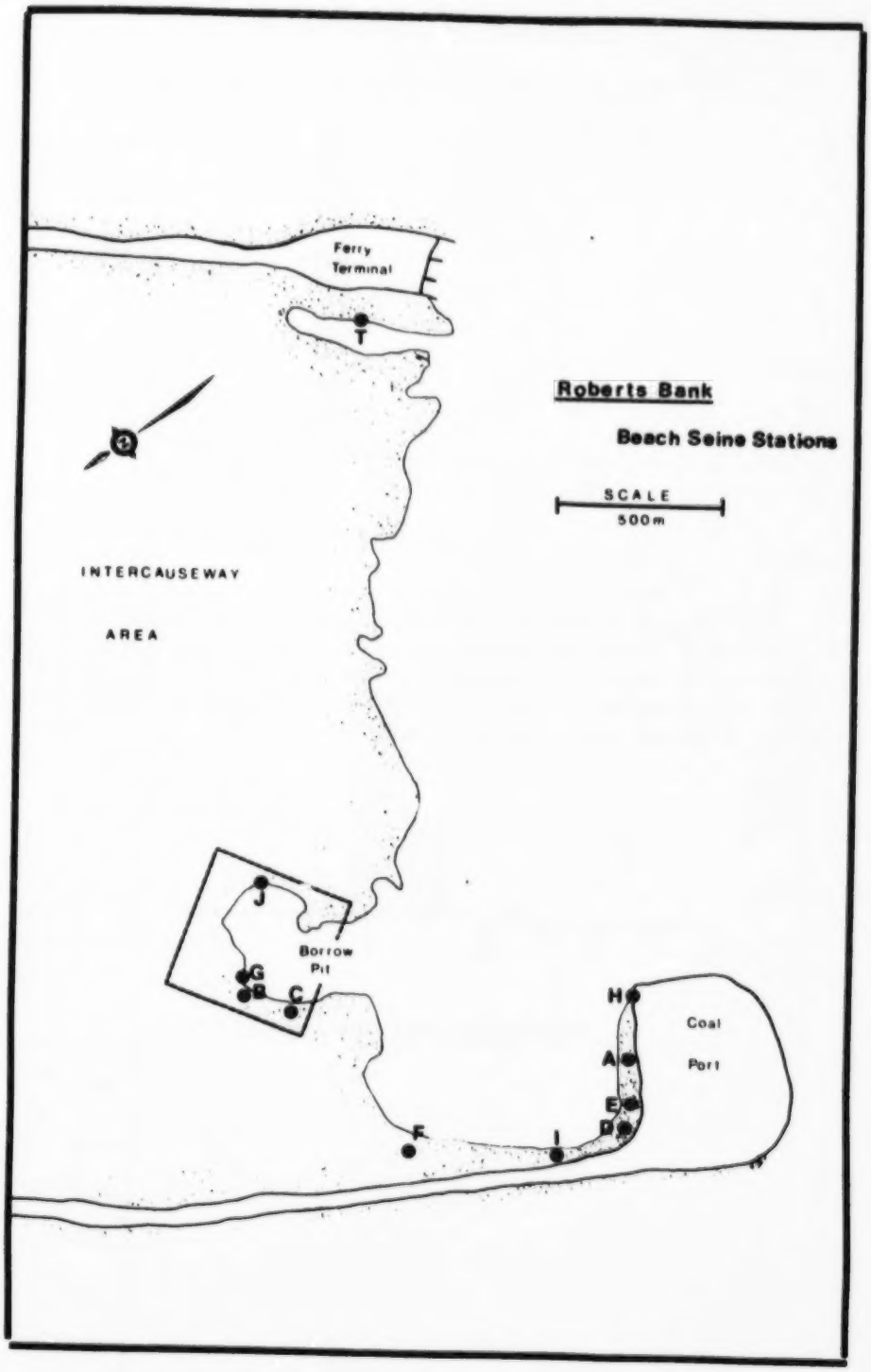
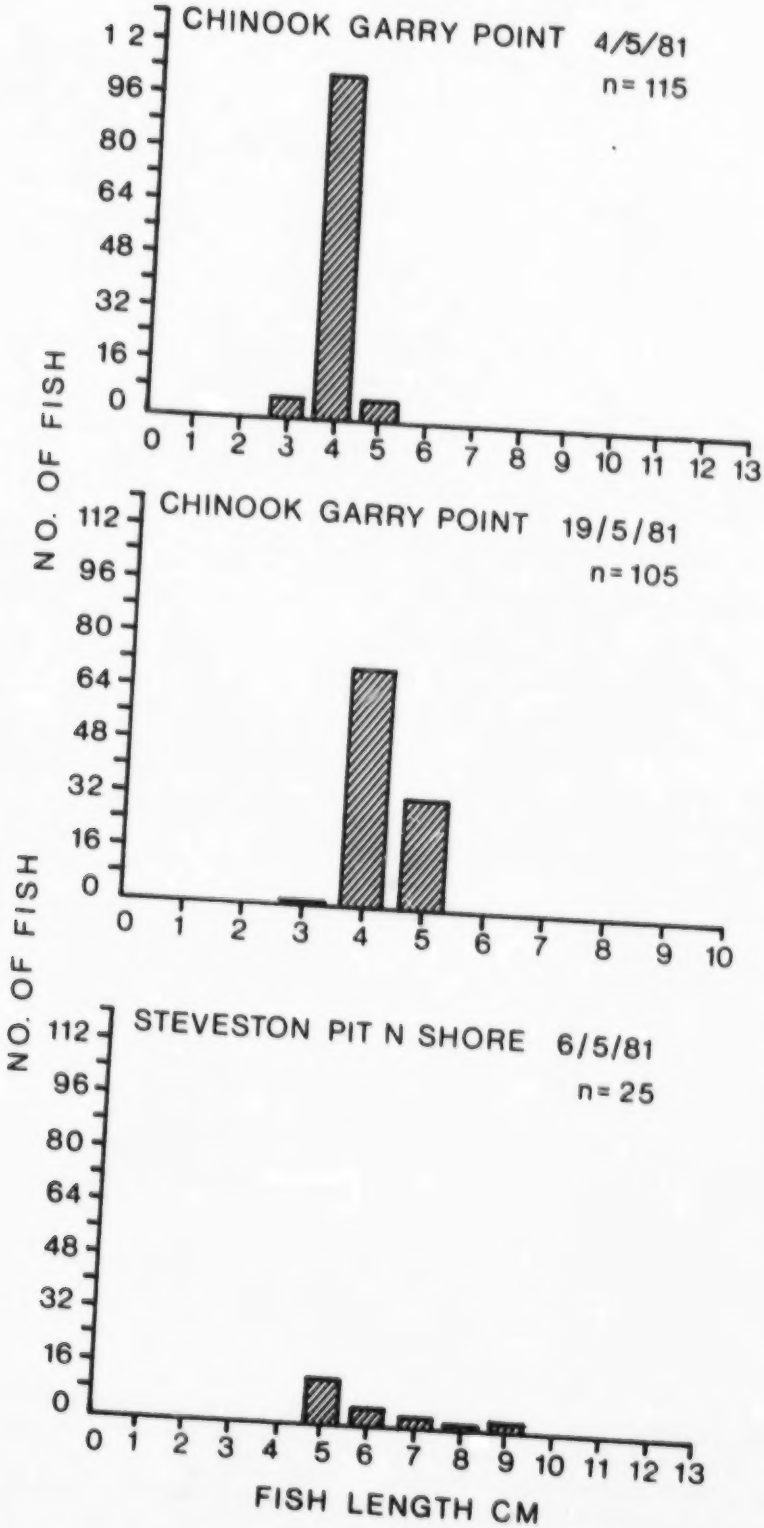


Fig. 1c. Station locations on southern Roberts Bank, Fraser River estuary.

Fig. 2. Length frequency data for chinook from Sturgeon Bank. Upper panel - fish taken for marking on May 19 at Garry Point Slough; middle panel - fish taken for marking on May 4 at Garry Point Slough; lower panel - fish taken on the north shore of Steveston Pit (Stns. 1, 2) on May 6 during mark recovery sampling.

STURGEON BANK



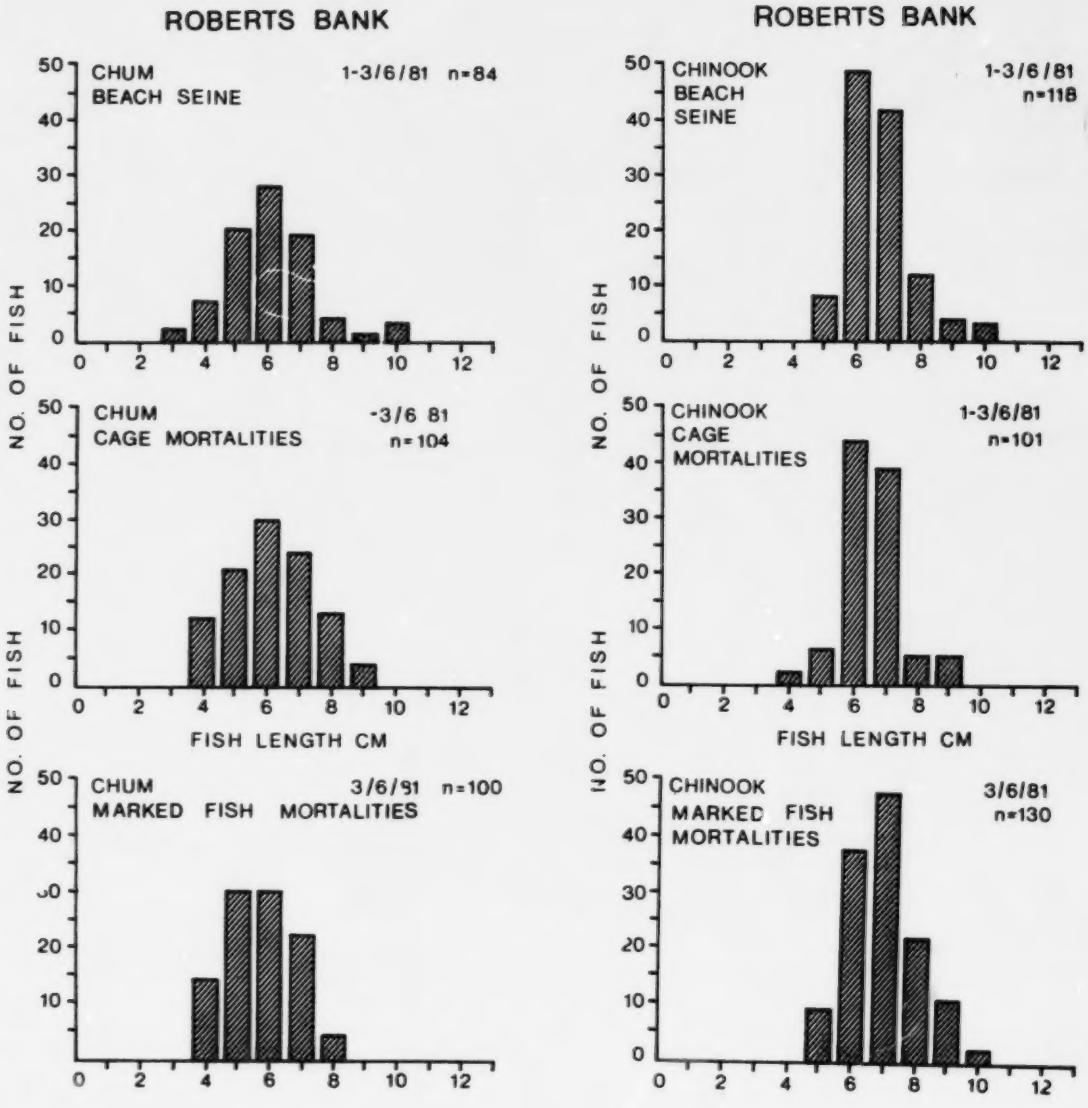


Fig. 3. Length frequency data for chinook (right panels) and chum (left panels) from Roberts Bank, Coal Port beach; lower panels - fish held in live cage; middle panels - fish taken during beach seining; upper panels - fish from marking.

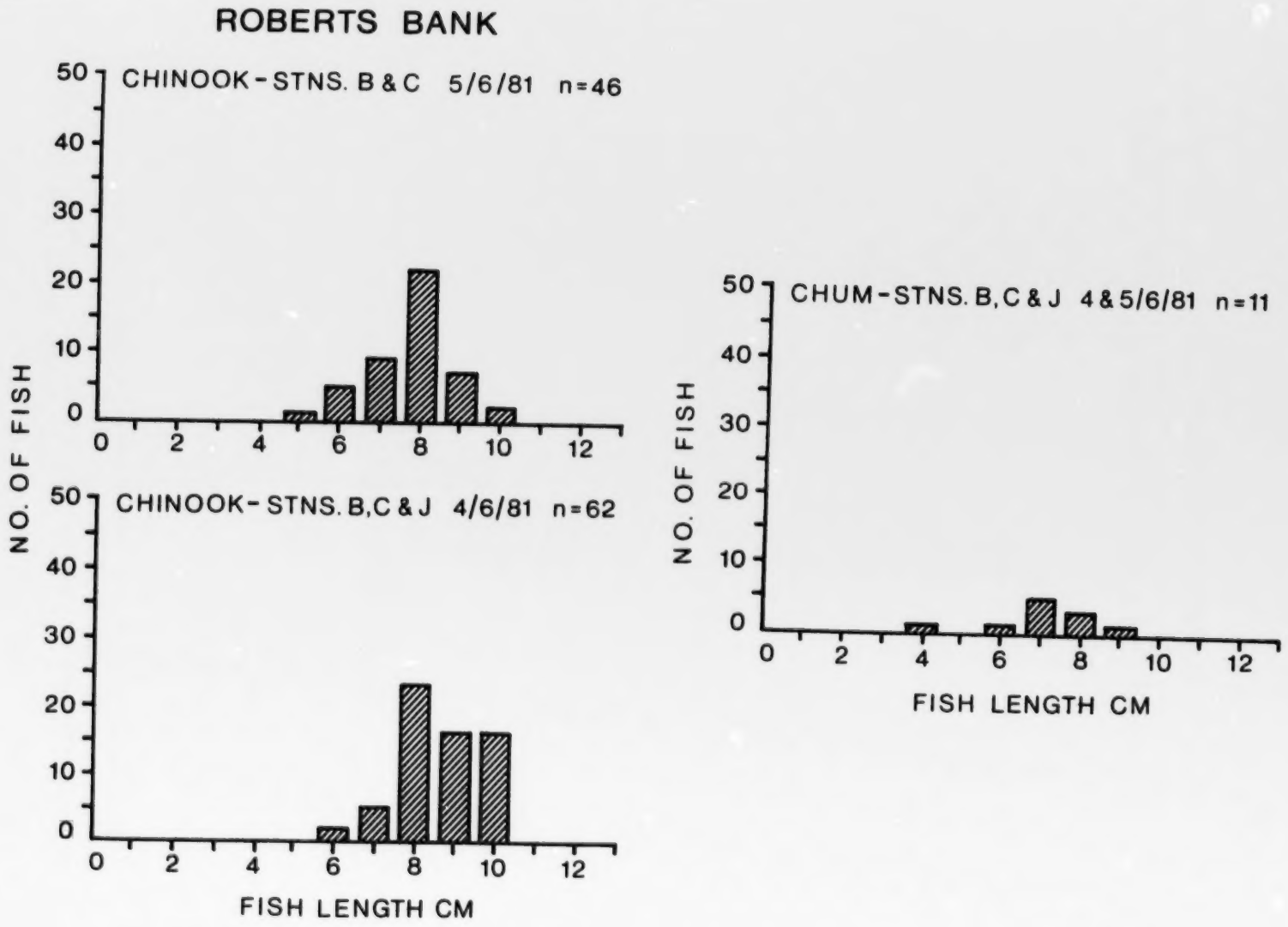


Fig. 4. Length frequency for chinook (left panels) and chum (right panel) from Roberts Bank borrow pit (Stns. B, C, J) during mark recovery sampling on the dates shown.

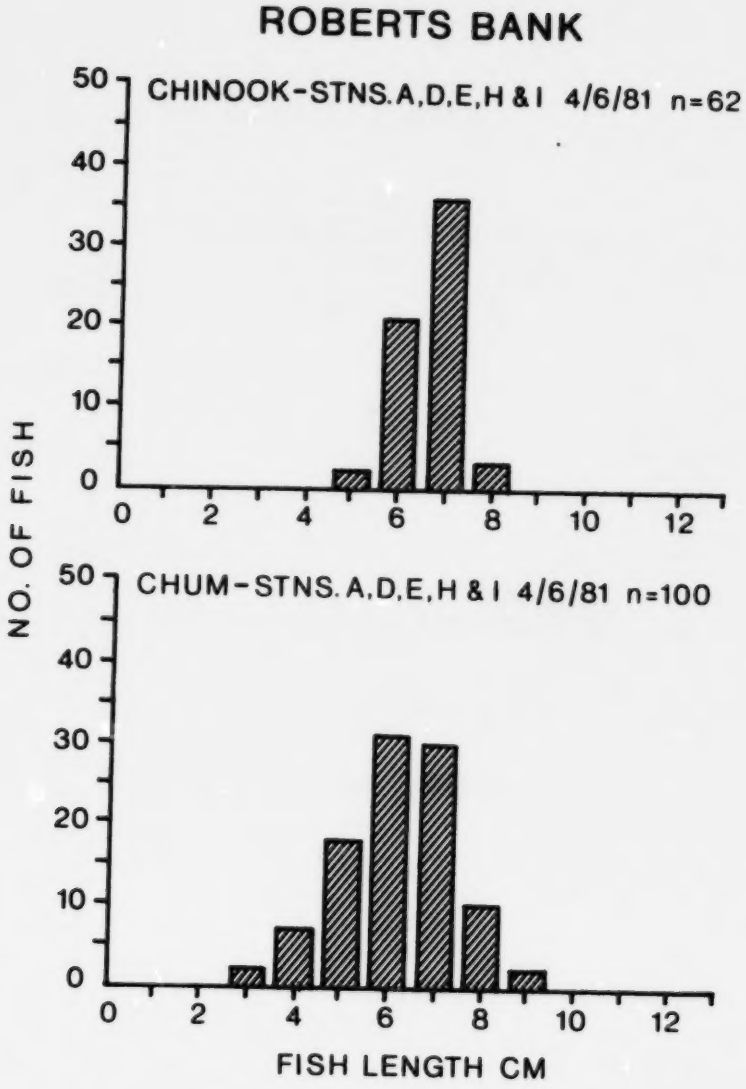


Fig. 5. Length frequency data for chinook (upper panel) and chum (lower panel) from Roberts Bank coal port shoreline (Stns. A, D, E, H, and I), obtained during mark recovery sampling on June 4.

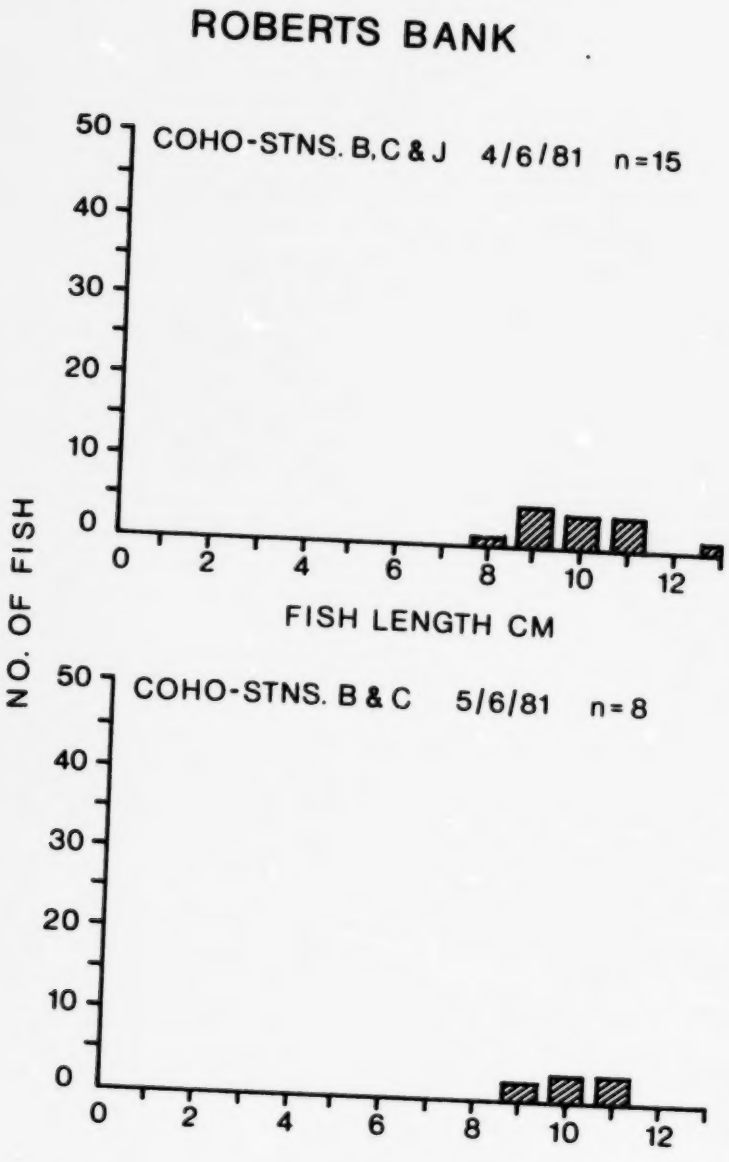


Fig. 6. Length frequency data for coho from Roberts Bank borrow pit, obtained during mark recovery sampling on June 4 and 5.